

UNITED STATES PATENT APPLICATION

FOR

SUPPORT APPARATUS FOR A HUMAN AND METHOD OF USE

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BACKGROUND OF THE INVENTION

1. FIELD OF INVENTION

[001] The invention relates generally to health care devices, and more specifically to human support apparatuses and methods used to facilitate human waste discharge or visual inspection of the human body.

2. ART BACKGROUND

[002] Invalids and mobility-impaired people, hereinafter the mobility-impaired, suffer from an inability to use existing toilet facilities. Existing toilet facilities are designed primarily for independent use by non-mobility impaired people. Typically, the mobility-impaired cannot clean their anal areas and must rely on health care providers to clean their anal and lower spine areas after discharging waste. Health care providers must accomplish this task by moving the mobility-impaired person. A simple task such as wiping the mobility-impaired person clean after discharging waste can require the mobility-impaired person to be tilted uncomfortably forward, awkwardly stood up or lifted to a bed, thereby creating additional problems for both the mobility-impaired as well as health care worker administering aid.

[003] Mobility-impaired individuals need to have their anal and lower spinal areas frequently inspected by health care workers for medical reasons. Chief among these medical reasons is inspection of the coccyx (tailbone), sacral and lower spine areas for pressure sores known as Decubitus Ulcers. A

Decubitus Ulcer can range from a very mild pink coloration of the skin, which disappears in a few hours after pressure is relieved on the area, to a deep wound extending to and sometimes through internal organs and into bone. The primary treatment regimen for Decubitus Ulcers is prevention through frequent inspection. Early, visual detection of pressure sores is central to reducing serious infection; inspection should occur frequently. These wounds occur frequently among the mobility-impaired and are of grave concern. Health care providers must go through a cumbersome process of moving a mobility-impaired person to a bed to perform a simple inspection. Health care facilities that fail to provide routine inspections could be considered negligent and risk exposure to liability.

[004] Attempts have been made to provide the mobility-impaired with improved apparatuses with which to discharge human waste. Two examples of such attempts are U.S. Patent No. 5,023,962, Steljes, "*Bedside Commode Station For Invalid Patients*," [Steljes] and U.S. Patent No. 6,286,154, Pitts et al., "*Portable Bedside Toilet Commode*," [Pitts]. Neither Steljes nor Pitts teach apparatuses that enable cleaning or inspection of the mobility-impaired by a health care worker. Steljes and Pitts provide bedside toilets for a person with a reduced mobility condition and presuppose that the person will be able to get from bed to the bedside toilet with greater ease and independence. Steljes, col. 2, ln. 19-24, and Pitts, col. 1, l. 50-55. Thus, Steljes and Pitts do not address the need for cleaning of the mobility-impaired person and inspection of the anal and lower spinal area by health care providers.

[005] As mentioned above, existing toilet facilities are unsuitable for use by mobility-impaired people. Previous attempts have been made to make the existing toilet facilities usable by mobility-impaired people. Such attempts can be seen in United States Patent No. 5,577,753, Pociask, "*Wheelchair and Commode Seat Therefor*," [Pociask]; United State Patent No. 6,324,705, "*Commode Chair with Enhanced User Support*," Zephier; and United States Patent No. 6,209,901, Patel, "*Wheel Chair with Waste Elimination Opening*," [Patel].

[006] These attempts at providing improved toilet apparatuses for mobility-impaired people do not address the need to provide ease of cleaning the anal and lower spinal areas of the mobility-impaired without having to move the mobility-impaired. Nor do these attempts address the need to inspect these sensitive areas to prevent the onset of Decubitus Ulcers. In fact, it is the very design of toilet or commode chairs represented by this group that is responsible for placing pressure on the bottom side of a mobility-impaired person which facilitates the onset of a Decubitus Ulcer.

[007] Another attempt at providing an improved toilet apparatus to mobility-impaired people can be seen in United States Patent No. 5,586,343, Mayle, "*Wheel Chair with a Removable Toilet Bowl and Seat*," [Mayle]. Mayle incorporates a toilet bowl and seat into a wheel chair and in so doing does not address the need to provide ease of cleaning the anal and lower spinal areas of the mobility-impaired without having to move the mobility-impaired. Nor does

Mayle address the need to inspect these sensitive areas to prevent the onset of Decubitus Ulcers.

[008] Attempts have been made to provide apparatuses to facilitate self-examination; such examples include United States Patent No. 3,989,359, Shutt, "Self-Examining Genital Mirror," [Shutt], and United Patent No. 6,273,575, Downs, et al., "Self Inspection Apparatus," [Downs]. Both Shutt and Downs provide apparatuses to perform self inspection by the user of the user's genital areas from the front of the user. Neither Shutt nor Downs teach apparatuses to facilitate inspection of the anal and lower spinal areas of a mobility-impaired person. Neither does Shutt nor Downs address the need to provide for cleaning of the anal and lower spinal areas of a mobility-impaired person following waste discharge without moving the mobility-impaired person.

[009] As mentioned above there exists a need to relieve the pressure that causes Decubitus Ulcers. Mobility-impaired people, because of their disabilities, find it difficult to sense points of excessive and prolonged pressure on their bodies. Particularly sensitive areas are the coccyx, sacral, and lower back regions of the skeleton. Prolonged pressure to these areas may lead to skin lesions, open sores, and infection. The key factor in healing Decubitus Ulcers in the early stage is alleviating pressure on the sore area to prevent it from worsening. Shearing or rubbing occurs on the coccyx and sacral area whenever there is friction on the surface of the skin imparted from another surface, be it clothing or a wheel chair seat surface.

[0010] The combined problems that arise from the existing devices, of pressure imparted to the anal and lower spinal areas and the dampness resulting from waste deposits can accelerate the formation of Decubitus Ulcers. All of the attempts described above do not mitigate these problems. The attempts previously discussed do not solve the problem of removing pressure on the anal and lower spinal areas of a mobility-impaired person to prevent the onset of Decubitus Ulcers. Neither do these attempts facilitate a health care provider's task of cleaning the mobility-impaired person following waste discharge without moving the mobility-impaired person.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The invention may best be understood by referring to the following description and accompanying drawings that are used to illustrate embodiments of the invention. The invention is illustrated by way of example in the embodiments and is not limited in the figures of the accompanying drawings, in which like references indicate similar elements. In the drawings:

[0012] **Figure 1** illustrates one embodiment of the invention where a continuous structure support surface has an aperture in a seat portion.

[0013] **Figure 2** illustrates one embodiment of the invention where a continuous structure support surface has a composite aperture.

[0014] **Figure 3** illustrates another embodiment of the invention utilizing a composite aperture in a support surface.

[0015] **Figure 4** illustrates a support surface configured with a frame according to one embodiment of the invention.

[0016] **Figure 5** depicts an embodiment of the invention with attached wheels.

[0017] **Figure 6A** illustrates a posterior view of one embodiment of the invention.

[0018] **Figure 6B** illustrates privacy panels according to one embodiment.

[0019] **Figure 7** illustrates one embodiment of the invention utilizing a video camera and display for viewing a human.

[0020] **Figure 8A** illustrates one embodiment of the invention adapted to a bed in a reclined position.

[0021] **Figure 8B** illustrates one embodiment of the invention adapted to a bed capable of being articulated to an elevated position.

DETAILED DESCRIPTION

[0022] In the following detailed description of embodiments of the invention, reference is made to the accompanying drawings in which like references indicate similar elements, and in which is shown by way of illustration, specific embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those of ordinary skill in the art to practice the invention. In other instances, well-known circuits, structures, and techniques have not been shown in detail in order not to obscure the understanding of this description. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the invention is defined only by the appended claims.

[0023] A support surface for a mobility-impaired person (human) is disclosed which eliminates pressure on the coccyx, sacral, and lower back regions of the human's anatomy. Eliminating pressure on these areas of the anatomy mitigates the problems of Decubitus Ulcer formation previously described. The support surface eliminates pressure on the anatomy and allows posterior access to the mobility-impaired person (human) when the human is supported on the support surface. Elimination of pressure and posterior access to the human are provided through an aperture in the support surface. Access to the anal area of the human facilitates cleaning of the human's anal and lower spinal area following waste discharge by a health care worker without having to move the human.

[0024] Additionally, inspection of the anal and lower spinal areas of the human are provided through the aperture in the support surface. Inspection of these areas can be performed by health care providers or even monitored by the human. In one embodiment, inspection is performed using a mirror positioned to provide a view of the human through the aperture in the support surface. In another embodiment, inspection is performed using a video camera and display. The display can be located in a plurality of places according to various embodiments of the invention. The invention is not limited by the mechanism used to provide a view of the human through the aperture.

[0025] Medical treatment can be rendered through the aperture in the support surface. Medication can be administered and/or manipulation of the anal and lower spinal areas can be effected through the aperture.

[0026] In various embodiments of the invention, privacy can be achieved by restricting the view of the human as desired. Privacy can be obtained by using a combination of side, rear, and top view blocking devices (privacy panels) which will be described in a subsequent section.

[0027] In the description that follows, reference will be made to the human who will be supported by support surfaces in the embodiments of the invention described herein. It will be understood by those of ordinary skill in the art that the human is not shown in the accompanying drawings so that the invention is not obscured.

[0028] **Figure 1** illustrates one embodiment of the invention where a support surface is a continuous structure and has an aperture in a seat portion.

With reference to **figure 1**, in one embodiment, a support surface 100 is a continuous member which can support a human (not shown) thereon. The support surface 100 includes a seat portion 102 and a back portion 104 with an aperture 106 in the seat portion 102 opening toward the back portion 104. In one embodiment, the aperture 106 can include a gap between the seat portion 102 and the back portion 104, as shown in **figure 1**. In one embodiment, the seat portion 102 can be sloped down and to the rear to facilitate holding the human therein. The seat portion 102 can be sloped at an angle 108 referenced from a horizontal 109, this angle 108 is variable and no limitation is implied thereby. In one embodiment, the angle 108 can be approximately five degrees.

[0029] In one embodiment, the seat portion 104 can be sloped back from a vertical 111 at an angle 110. The angle 110 is also variable and no limitation is implied thereby. In one embodiment, the angle 110 can be approximately ten degrees. Those of ordinary skill in the art will recognize that angles 108 and 110 are variable and that, in one embodiment, the support surface 100 can be made adjustable such that these angles could be adjusted to suit the particular desire for comfort of the individual human using the support surface 100.

[0030] In one embodiment, the seat portion 102 can include a general concavity to provide increased support to the human seated therein. The general concavity of the seat portion 102 can exist with respect to a local X and/or a local Y axis of the plane containing the seat portion 102, as shown in **figure 1**. The back portion 104 can contain a general concavity with respect to a local X and/or a local Y axis (not shown) of the plane containing the back portion

104. The general concavity described herein is meant to be given broad interpretation and is not confined to any one set curve or shape. General concavity is meant to include departures from a flat plane containing the seat portion 102 or the back portion 104. General concavity can also include a multi-curved surface. In one or more embodiments, the support surface, as described herein and shown in all of the figures, can embody the general concavity described above.

[0031] An ergonomic feature, such as a lumbar support, can be incorporated into the back portion 104 in conjunction with or in place of the general concavity described in relation to the back portion 104. For example a lumbar support can be built into the lower portion of the back portion 104 to support the lumbar region of the human's lower back.

[0032] In one embodiment, the width of seat portion 102 is 480 millimeters at a front end indicated at 112 and 460 millimeters wide at a rear end in the vicinity of aperture 106, and a length of the seat portion 102 is 450 millimeters. Similarly, in one embodiment, the back portion 104 has a width of 460 millimeters and a length of 560 millimeters.

[0033] In one embodiment, the support surface can be made from a single structural member such as molded fiberglass, formed metal, wood or a machined material or a molded material such as plastic or fiber reinforced plastic. The structural member can be padded with a cushion material, such as foam rubber, a gel-padded cushion, etc. Various low friction covering materials can be used over the cushion material to provide a uniform pressure distribution

across the bottom of the human seated on the support surface. The present invention is not limited by the material used to make the support surface. In one embodiment, the seat portion 102 and the back portion 104 can be padded with a two inch thick foam rubber cushion with an outer surface of vinyl.

[0034] It will be recognized by those of ordinary skill in the art that the construction and dimensions listed herein are not restrictive and are merely a set of materials and dimensions for one or more embodiments of the invention. The present invention is not limited by the materials or dimensions of the support surface.

[0035] **Figure 2** illustrates one embodiment of the invention where a support surface is constructed as a continuous structure and has a composite aperture. With reference to **figure 2**, in one embodiment, a support surface 200 includes a seat portion 202 with an aperture 206, and a back portion 204 with an aperture 208. The aperture 206 and the aperture 208 merge together to form a composite aperture 210. Composite aperture 210 illustrates another embodiment of an aperture through which a human can be cleaned following waste discharge.

[0036] The invention is not limited by the shape of the aperture incorporated into the support surfaces shown in the figures. In various embodiments, the aperture contained in the support surface can contain a gap between the seat portion and the back portion. The aperture 210 can be shaped according to different embodiments to accommodate the geometry of different sized humans. For example, in one embodiment, the composite aperture 210

can have rounded corners as shown in **figure 1** and **figure 2**. In one embodiment, the radius of the rounded corner of aperture 206 is approximately 70 millimeters. In one embodiment, the length of aperture 206 is 260 millimeters. In one embodiment, the width of aperture 210 is approximately 150 millimeters. In one embodiment, the radius of the rounded corner of aperture 208 is 50 millimeters and the length of aperture 208 is 200 millimeters.

[0037] **Figure 3** illustrates another embodiment of the invention utilizing a composite aperture in a support surface. With reference to **figure 3**, in one embodiment, a support surface 300 includes a seat portion 302 that has an aperture 306. The aperture 306 opens toward the posterior end of the seat portion 302 and toward a back portion 304. The back portion 304 includes an aperture 308. The aperture 308 opens toward the lower end of the seat portion 304. The aperture 306 and the aperture 308 merge together to form a composite aperture 310. In one embodiment, the composite aperture 310 can include a gap between the seat portion 302 and the back portion 304, as shown in **figure 3**. The composite aperture 310 can be sized as needed to provide access to the human's anal and lower spinal region to facilitate cleaning after the human discharges waste as well as being sized as needed to eliminate contact pressure on the human's bottom.

[0038] **Figure 4** illustrates a support surface configured with a frame according to one embodiment of the invention. With reference to **figure 4**, in one embodiment, a support surface 400 includes a seat portion 402, a back portion 404, and a frame 410 and a frame 412 to position the seat portion 402

and the back portion 404 there between. The seat portion 402 includes an aperture 406 opening toward the posterior end of the seat portion 402 and toward the back portion 404. In one embodiment, the back portion 404 includes an aperture 408 that opens toward the bottom of back portion 404 and toward the seat portion 402. In one embodiment, the aperture 406 and the aperture 408 merge to form a composite aperture. The composite aperture can include a gap between the seat portion 402 and the back portion 404 as illustrated in **figure 4**. In one embodiment, the support surface 400 includes an armrest 414 and an armrest 416. Arm rest 414 has a front end 418 and a rear end 420. Similarly, arm rest 414 has a front end and a rear end, which ends are not marked to preserve clarity in **figure 4**. In one embodiment, a footrest 418 provides stability to a human resting on the seat portion 402 and the seat back 404.

[0039] In one or more embodiments, the arm rest 416 slopes down from the front end 418 to the rear end 420. Such a “down” slope is equivalent to the front end 418 being elevated relative to the rear end 420. Arm rest 414 can be configured to slope in a fashion parallel to arm rest 416. The sloped arm rests serve to stabilize the human seated on the support surface 400. In one embodiment, the slope of the arm rest 416 can be described as an angle of approximately ten (10) degrees, measured from a horizontal, such as the horizontal 109 illustrated in **figure 1**. No limitation is implied by a slope of approximately ten (10) degrees.

[0040] In one embodiment, the arm rests 416 and 418 can be configured to be adjustable, with a variable slope. In one position of adjustment, the arm

rests can be configured as described above (sloping down to the rear end 420) to facilitate stabilizing the human when seated on the support surface 400. In another position of adjustment, the arms rests can be adjusted such that the arm rests slope from the rear end 420 to the front end 418, thereby facilitating the human's attempt to rise up and out of the support surface 400. In this position of adjustment the rear end 420 is at a greater elevation than the front end 418. Various positions of adjustment are possible in between the two positions described above. It is not a requirement that the arm rests be configured at the same slope. In one or more embodiments the arms rests can be configured with different slopes as well as being configured with the same slope.

[0041] Those of ordinary skill in the art will recognize that the frame 410 and the frame 412 can be constructed in a variety of ways. For example, the frame 410 can be a continuous structural plate type member or the frame can be a perimeter frame with an open interior. The open interior of the perimeter frame can provide access to a human when seated on the support surface 400. The perimeter frame can be covered with a privacy panel to limit the view of the human seated on the support surface 400. In one embodiment, such a privacy panel on a perimeter frame would appear as shown in figure 4 at 410; effectively blocking side views of the human seated on the support surface 400. In one embodiment, the frame 410 and the frame 412 can be a unified structure or in another embodiment the frame 412 can be a separate structure from frame 410. Those of ordinary skill in the art will appreciate that the frame utilized to position the seat portion 402 and the back portion 404 can be created with many well-

known techniques, several of which have been described above. The present invention is not limited by the type of frame utilized herein.

[0042] **Figure 5** depicts an embodiment of the invention with attached wheels. With respect to **figure 5**, an embodiment of the invention is illustrated with a wheel 502 and a wheel 504 to provide mobility of the support surface 500. **Figure 5** illustrates an embodiment of the invention incorporated into a wheelchair. The support surface 500 can also be referred to as a mobile commode chair. A wheel lock mechanism is indicated at 506 and can lock the wheel 502, a similar lock mechanism (not shown) is used to lock wheel 504. Those of ordinary skill in the art will recognize that the wheel lock mechanism can be configured as is known in the art utilizing such well-known techniques as a friction brake applying pressure to the wheels. Additional smaller wheels, one or more, (not shown) are used, in one embodiment, under the front portion of the support surface 500 as indicated at 508 to compliment the larger wheels 502 and 504 to provide mobility.

[0043] **Figure 6A** illustrates a posterior view of one embodiment of the invention. With respect to **figure 6A**, a posterior view of a support surface 600 is shown. A human (not shown) rests on a seat portion 602, thereby positioning his or her anus above an aperture 606 in the seat portion 602. Waste, expelled from the human (not shown), falls into a waste collection pan 608. Health care providers (not shown) have posterior access to the human and can clean the anal and lower spinal area of the human. The health care worker can inspect the anal and lower spinal regions of the human without moving the human from

the support surface 600. Medical services can be administered to the human utilizing the posterior access afforded by the aperture in the support surface 600. As described with respect to **figure 1, figure 3, figure 4, figure 5, figure 6A, figure 6B, and figure 7**, the composite aperture can include a gap between the seat portion 602 and the back portion 604 as shown in **figure 6A** as desired to provide sufficient access to the human.

[0044] Inspection of the human is accomplished according to several embodiments of the invention. The waste collection pan 608 can be removed to provide a view of the human through the aperture 606 in conjunction with a mirror 610 located beneath the aperture 606. Alternatively, or in addition to inspection utilizing the mirror, inspection of the human through the aperture can be accomplished by video surveillance and display.

[0045] In one or more embodiments of the invention, privacy can be provided to the human using privacy panels. **Figure 6B** illustrates an embodiment of the invention using privacy panels. With respect to **figure 6B**, an exploded view of privacy panels and a support surface are shown at 650. Privacy can be provided to the human by placing a tray 656 across and above the lap area of the human seated on a support surface 652; the tray 656 can extend from arm rest 416 to arm rest 414. The tray 656 is removable and allows the human to partake of activities while seated on the support surface 652.

[0046] Additional privacy can be provided to the human seated on the support surface 652 by using a privacy panel to block the posterior view of the human. A privacy panel 654 can be a removable curtain, panel or door that can

be attached or removed as needed to facilitate access to the human or to block the posterior view, thereby providing privacy. Many ways of attaching a privacy panel are well-known in the art such as snaps, hinges, magnetic strip, channels, string, rollers, etc. The present invention is not limited by the construction of the privacy panel or the attachment of the privacy panel to the support surface 652.

[0047] The privacy panel can extend to cover the entire view of the human visible through the aperture or apertures described herein. In one embodiment, the posterior view can be blocked by extending the privacy panel as indicated by the dashed line around section 655 of the privacy panel; thereby extending the privacy panel all the way to the top of a back portion 653 of the support surface 652.

[0048] **Figure 7** illustrates one embodiment of the invention utilizing a video camera and display for viewing a human. With respect to **figure 7**, support surface 700 includes a seat portion 702; the seat portion 702 has an aperture 703. The support surface includes a back portion 714. In one embodiment, the aperture 703 can include a gap between the seat portion 702 and the back portion 714 as shown in **figure 7**. The human (not shown) seated on the seat portion 702 is positioned such that the human's anus is proximate to the aperture 703. Waste expelled from the human (not shown) can fall into a waste collection bucket which would be positioned similarly as the waste collection bucket is shown in **figure 6A** at 608. The waste collection bucket is not shown in **figure 7** so that the inspection structures are not obscured. A video camera 706 positioned below the seat portion 702 obtains a view of the human

through the aperture 703. The video signal obtained from the video camera 706 can be transmitted from antenna 708 and received by a video display unit 710 and antenna 712. It will be recognized by those of ordinary skill in the art that video surveillance and display are readily implemented in a variety of ways utilizing known structures and methods. For example, in **figure 7**, a short range wireless system is shown. Alternatively, video camera 706 could be wired to the video display unit 710 with metallic coaxial cables or optical fiber transmission lines.

[0049] The video display unit 710 can be located in a variety of places according to different embodiments of the invention. For example, the video display unit 710 can be located on the support structure 700 in a variety of ways utilizing a support arm (not shown) attached to support surface 700. Alternatively, the video display unit 710 could be placed on a floor mounted stand in the vicinity of the human seated on the support surface 700. In yet another embodiment, of the invention, the video display unit 710 can be a portable device utilized by a health care provider to monitor the status of the human. In yet another embodiment, of the invention, the video display device can be part of a central video surveillance system deployed within a private home or health care facility.

[0050] The present invention is not limited by the structures utilized to provide a view of the human through the aperture 703. In one embodiment of the invention, multiple views of the human (not shown) seated on the support surface can be produced by different viewing structures and methods. A mirror

704 positioned beneath the aperture 703 can provide a view of the human seated on the support surface and a second view can be provided from the video camera 706 and video display 710. In one embodiment, a health care provider could utilize the mirror 704 when cleaning the human and the view provided by the video camera could be used in a central monitoring facility where a plurality of video displays were arrayed to monitor the status of a plurality of humans; each human seated in a support surface 700 with one or more individual video cameras per human. Multiple video cameras could be used to provide multiple views of patients that were of concern. A video camera could be operated remotely to provide a zoom view of areas of concern on a human. In yet another embodiment, a single video display 710 could be used to cycle through a plurality of humans seated in individual support surfaces 700. Such an arrangement could be deployed in a health care facility to monitor the health of the plurality of humans.

[0051] In another embodiment, the present invention can be adapted to a bed. Such a bed can be adjustable from a reclined position to an elevated position. **Figure 8A** illustrates one embodiment of the invention adapted to a bed in a reclined position. With respect to **figure 8A**, a reclined support surface is shown generally at 800. Reclined support surface 800 includes a first portion 808 flexibly coupled with a second portion 802. The first portion 808 and the second portion 802 can flexibly articulate about axis 804. Either one or both of the first portion 808 and the second portion 802 can contain an aperture 806. A human (not shown) can recline on the support surface 800 with the human's

anus positioned proximate to the aperture 806. Support surface 800 can articulate to an elevated position as shown in **figure 8B**.

[0052] **Figure 8B** illustrates one embodiment of the invention adapted to a bed capable of being articulated to an elevated position. With respect to **figure 8B**, an elevated support surface is shown at 850. The second portion 802 is elevated making an angle 856 with the first portion 808. The human can be elevated from the reclined position in **figure 8A** to a more seated position in **figure 8B** to facilitate human waste discharge, cleaning by health care providers, medical examination, and administration of medical services as needed. The angle 856 is arbitrary, and those of ordinary skill in the art will recognize that such an embodiment can be configured in a general manner allowing for general positioning of the first portion 808 and the second portion 802, in much the same way that hospital beds are adjusted.

[0053] As used in this description, “one embodiment” or “an embodiment” or similar phrases means that feature(s) being described are included in at least one embodiment of the invention. References to “one embodiment” in this description do not necessarily refer to the same embodiment; however, neither are such embodiments mutually exclusive. Nor does “one embodiment” imply that there is but a single embodiment of the invention. For example, a feature, structure, act, etc. described in “one embodiment” may also be included in other embodiments. Thus, the invention may include a variety of combinations and/or integrations of the embodiments described herein.

[0054] While the invention has been described in terms of several embodiments, those of ordinary skill in the art will recognize that the invention is not limited to the embodiments described, but can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of limiting.